Equation 20 $$P\max = \frac{\left(\delta j - \alpha(\Delta T)\left(L + \frac{L2}{2}\right)\right)}{\left(\frac{w}{2}\right)\left(\frac{L^2}{2EI} + \frac{L}{Kr}\right)}$$

Equation 21 $$\delta tot = \frac{P\max L^3}{3EI} + \frac{P\max L^2}{Kr} + \frac{P\max}{K1}$$

Equation 22 $$FL = P\max + \left(K2 * \delta tot\right)$$

Where,

Pmax = Force required to close the expansion joint (force units)

δtot = Lateral displacement limit (length)

δj = Joint width (length)

K1 = Abutment stiffness (trans-rot) (force/length)

K2 = Pile group stiffness (trans-rot)(force/length)

Kr = rotational stiffness of the bearing pad in the transverse direction (force-length/rad)

L = exterior span lengths (length)

L2 = interior span length (length)

w = width of span (length)

EI = flexural stiffness of the superstructure (trans-rot)(force-lenght^2)

α = coefficient of thermal expansion (1/Temperature)

ΔT = Temperature

An important parameter for the application of equations 15, 16 , and 17 to establish limit state is the rotational stiffness at the key joint locations. Results from full scale testing conducted herein provided data on super to sub structure's rotational stiffness in longitudinal direction for three different piles. An illustration of the application of the limit state equation is provided in the next section.

The Halifax County Bridge is analyzed to determine if the joint closure serviceability limit state. This bridge consists of 9 spans where the interior girder spans are supported by a continuous cap beam with 8 piles. The supporting square piles are 18 inch (45.7cm)